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Contents

Chapter 1

(I^-) (I^{3-}) (I^{3-})
Winkler(1888) Carpenter(1965) . (2013-230)
, , .

Chapter 2

($MnCl_2$) ($NaOH/NaI$) (Mn^{2+})
($Mn(OH)_2$) (1). 4 ($MnO(OH)_2$)
(2). 4 ($MnO(OH)_2$) (I^-)
(I_2) (3). (I_2) (I^-) (I^{3-}) (4).
. (I^{3-}) (I^-) .
(I^{3-}) (I^-) (I^{3-}) (5).
(I^-) (I^{3-}) (6).
(I^{3-}) (I^-) . 2 1 (I^{3-}) 1/2
(I^{3-}) , 4 ($MnO(OH)_2$) 1 (I_2) . (O_2)
1 2 (I_2) 1 (I_2) (O_2) 1/2 . (O_2) (I^{3-})
(I^-) 4 .

(1) $Mn^{2+} + 2OH^- \rightarrow Mn(OH)_2$

(2) $2Mn(OH)_2 + O_2 \rightarrow 2MnO(OH)_2$

(3) $2Mn(OH)_2 + 6H^+ + 2I^- \rightarrow 2Mn^{2+} + I_2 + 6H_2O$

(4) $I_2 + I^- = I^{3-}$

(5) $I^{3-} + 2{S_2O_3}^{2-} \rightarrow 3I^- + {S_4O_6}^{2-}$

(6) $+ I^{3-} \rightarrow$

0-400 mol kg^{-1} . 0.1% ± 0.3 mol kg^{-1} .

Chapter 3

.

Chapter 4

(4.1), (4.2) . 10% 3 .

4.1

4.1.1

125 ml Pyrex . .
±0.003 ml .

4.1.2 /

3 . 1(MnCl2), 2(NaI/NaOH), 3(Sulphuric Acid) 3 1.0 ml ±0.02 ml . 2(NaI/NaOH) , / .
. 1(MnCl2) 2(NaI/NaOH)
. .

4.1.3

(Niskin bottle) (Tygon tube) .
. Tygon tube .
. .

4.1.4

0.1 oC .
mol L-1 mol kg-1 . .

4.1.5

300g 0.001g .

4.2

4.2.1

, , .

4.2.2

1 ml, 2 ml, 5 ml .
.(; Metrohm 665 Dosimat burette, SCHOTT Instruments TITRONIC universal)

4.2.3

(KIO3) 1.0 ml 10.0 ml . SOCOREX Calibrex 520 bottle-top . 1-11 ml 0.25 ml .
±0.002-0.005 ml . MetrohmTM .

4.2.4

25mm .

4.2.5

250 ml .

Chapter 5

(5.1), (5.2), (5.3), (5.4), (5.5). (5.6) .

5.1 3M ($MnCl_2 \cdot 4H_2O$)

($MnCl_2 \cdot 4H_2O$) 600 g 500-700 ml 1000 mL . .
. (,) . ($MnSO_4 \cdot 4H_2O$) 480 g 1000 ml .

5.2 (NaI/NaOH)

(NaOH) 320 g 500 ml . .
(NaI) 600 g . (NaN_3) 10 g . 1000 ml .
. (,) .

5.3 50% (v/v) (H_2SO_4)

(H_2SO_4) 50 mL 1:1 (50 ml 50 ml) .
50 ml . 100 mL . (,) .
, .

5.4 1%

1 g 50 mL 100 mL .
. 1 , (Hg_2I_2) .

5.5 0.025 N ($Na_2S_2O_3 \cdot 5H_2O$)

($Na_2S_2O_3 \cdot 5H_2O$) 6.205 g 1000 mL .
. . 400 mol kg^{-1}
2 ml .

$$4 \times (C_1 \times V_1) = C_2 \times V_2$$

,
C_1 : $[O_2] = 400 \mu mol L^{-1}$
V_1 : (10%) $= 14ml$
C_2 : $[Na_2S_2O_3]$
V_1 : (2ml)
4:1 (O_2) 4 $Na_2S_2O_3$
,
$[Na_2S_2O_3] = \frac{400 \mu mol\ L^{-1} \times 140ml \times 4}{2ml} \simeq 0.11M$
$[Na\ 2\ S\ 2\ O\ 3\ ] = 400 * 10^{-}6 * 140 * 4/Burettevolume(2ml) = 0.11M$

($Na_2S_2O_3 \cdot 5H_2O$) 1 248.17 g 27.4 g 1000 ml .
(Na2S2O3) 1 158.09 g 17.4 g . 2-5
1L .

5.6 0.001667 M (KIO_3,0.0100 N)

(KIO_3) 0.5 g 120℃ 2 . 0.3567g 1000
mL . (tp) .
0.3567g , .

$$M(\ ) = \frac{1L}{(214.0g)}$$

Chapter 6

6.1

.

. .

, , , . CFCs, Helium, Noble gases(aragon and zenon), O^{17}, Oxygen, and pCO_2 .

6.2

1. .
2. ( ) .
3. .
4. .
   . 45 .
   2-3 . .
5. . .
   CTD .
6. 1 ml 1 ml 90
   . .
   . NaI/NaOH .
7. . 2 ml .
8. .
9. .
   .
10. 30 . .
11. 1 30 2 .
    .

Chapter 7

7.1

1. .
2. (KIO_3) 1 ml .
3. 50 % 1ml .
4. NaI/NaOH 1ml .
5. $MnCl_2$ 1 ml .
6.
7. . . (V1) .
   V1 V3 .
8. (KIO_3) 1 ml (V2) .

7.2 ( ) by Carpenter (1965) method

1. .
2. .
3. 10.0 ml (0.00167 M) .
4. 50% 1 ml .
5. (NaI/NaOH) 1 ml . (I^-) (IO_3^-)
   (I_3^-) ($IO_3^- + 8I^- + 6H^+ \rightarrow 3I_3^- + 3H_2O$).
6. 1 ml .
7.
8. . 1 ml . .
   ($I_3^- + 2S_2O_3^{2-} \rightarrow 3I^- + S_4O_6^{2-}$). ± 0.03 ml .
9. (IO_3^-) 1 ($S_2O_3^{2-}$) 6 .
   . 4 . 0.3% , ml l Vstd .

$$C_{Na_2S_2O_3\cdot 5H_2O} = \frac{C_{KIO_3} \times 10.0 \times 6}{V_{Na_2S_2O_3\cdot 5H_2O}}$$

$C_{Na_2S_2O_3\cdot 5H_2O} : Na_2S_2O_3 \cdot 5H_2O$ (mole/L)
$C_{KIO_3} : KIO_3$ (mole/L)
$V_{Na_2S_2O_3\cdot 5H_2O} : Na_2S_2O_3 \cdot 5H_2O$ (mL)

7.3 (Standard-curve)

1. (KIO_3) 2, 4, 6, 8, 10 ml 5 .
2. .

7.4

1. .
2. .
3. 50% 1 ml . 50% 1 ml . pH (I_2) . .
4. (t_L) .
5. . ml ul Vsam .
6. . .

Chapter 8

8.1

I_2 .

$V_{blk} = V_1\text{-}V_2$

$V_{blk} = V_1\text{-}(V_2\text{-}(V_3\text{-}1)) = 2V_1\text{-}V_2\text{-}V_3$
V_1: KIO3 1 ml
V_2: KIO_3 1 ml
V_3: KIO_3 1 ml
V_{blk} ml .

8.2 KIO_3

KIO_3 (t_p) 20 ℃ KIO_3 .

$$M(KIO_3,\ 20^{\circ}\mathrm{C}) = \frac{m(KIO_3)/(213.995g \cdot mol^{-1})}{V_s} \times \frac{0.998206}{\rho_w(t_p)}$$

$m(KIO_3)$: KIO_3
V_s : KIO_3 (t_p)
$213.995g\ mol^{-1}$: KIO_3 1
$\rho_w(t_p)$:
$V_s = V_s[1 + \alpha_V(t_L - 20)]$
α_V(Pyrex): $9.75 \times 10^{-6}\ ^{\circ}K^{-1}$

8.3

(tL) .

$$M(Na_2S_2O_3,\ t_L) = \frac{6000 \times V(KIO_3,\ t_L) \times M(KIO_3,\ t_L)}{V_{std} - V_{blk}}$$

,
$V(KIO_3,\ t_L) = V(KIO_3,\ 20°\text{C}) \times (1 + 9.75 \times 10^{-6}(t_L - 20))$
$M(KIO_3,\ t_L) = M(KIO_3,\ 20°\text{C}) \times \frac{\rho_W(t_L)}{0.998206}$
$6000 = \frac{6mol\ Na_2S_2O_3}{1mol\ KIO_3} \times \frac{1000\mu l}{1ml}$
V_{std}:KIO_3
V_{blk}: (reagent blank) ml l .

8.4

(+ O_2) .

$$n(O_2) = (V_{sam} - V_{blk}) \times M(Na_2S_2O_3,\ t_L) \times \frac{1L}{10^6\mu l} \times \frac{1mol\ O_2}{4mol\ Na_2S_2O_3}$$

$$C(O_2) = \frac{[n(O_2) - 7.6 \times 10^{-8}]}{m(sample)}$$

,
7.6×10^8 : $(MnCl_2 + NaI/NaOH)$ 2 ml (O_2)
$m(sample)$ (kg) .
$m(sample) = V(O_2$, 20°C) $\times [1 + 9.75 \times 10^{-6}(t_s - 20)] - 2 \times \rho(t_S),\ S)$
,
t_S
2
ρ_{SW}

Chapter 9

/ (QA/QC)

5 10 . 0.44 mol/L .
0.16 0.94 mol/L . .
±0.1 % ,
±0.45 mol kg^{-1} .
. . .
1.78 mol/L . . CTD
. CTD .

Chapter 10